embodiment, ring gear **80**, sun gear **84** and planet gears **82** include double-helical, or herringbone, tooth configurations that facilitate flow of lubrication oil through epicyclic gear system **32**.

Ring gear **80** of epicyclic gear system **32** is connected to fan shaft **26** and second-stage shaft **30** through flanged connection **60**. Fan shaft **26** is connected to compressor shaft **54** such that fan shaft drives ring gear **80** at the same speed as compressor shaft **54**. Likewise, second-stage shaft **30** is connected to second-stage rotor **62** to drive second-stage fan blades **14**B at the same speed as compressor shaft **54**. Thus, second-stage fan blades **14**B are directly driven by compressor shaft **54** without needing to go through a gear reduction system. Ring gear **80** is also directly driven by compressor shaft **54** to drive first-stage shaft **28** through planet gears **82** and sun gear **84**. First-stage shaft **28** is connected to carrier **88** with, for example, threaded fasteners at bores **122** of carrier **88** and bores **124** of first-stage shaft **28**. In other embodiments, second-stage shaft **28** is connected to carrier **88** using a flexible torque plate coupling in conjunction with bores **122**, as is described in U.S. Pat. No. 5,466,198 by McKibbin et al., which is herein incorporated by this reference. As compressor shaft rotates ring gear **80**, ring gear **80** spins planet gears **82** around stationary sun gear **84**. Planet gears **82** pull gear carrier **88** about axis A in the same rotational direction as ring gear **80**, but at a reduced rate. Thus, first-stage shaft **28** is driven to rotate about axis A in the same direction as second-stage shaft **30**, but at a slower speed.

Epicyclic gear system **32** achieves a reduction in the rotational speed of first-stage shaft **28** commensurate with optimal operation of two-stage fan section **12**. For example, differential gear systems, in which the sun gear, the carrier and the ring gear all rotate, have been employed to rotate counter-rotating fan sections in other gas turbine propulsion systems. Differential gear reduction systems, however, achieve gear reduction ratios on the order of 8:1 or more, which would result in the first-stage fan shaft rotating at about thirteen percent of that of the second-stage fan shaft. In co-rotating, two-stage turbofans, it is desirable that the two fan stages rotate at similar speeds such that mass flows generated by each stage are closely matched. With the gear system of the present invention, in which sun gear **84** is maintained stationary by static torque tube **70**, lower gear reduction ratios are attainable, as is illustrated by equation (1), where NR is the number of teeth in ring gear **80** and Ns is the number of teeth in sun gear **84**.

$$\frac{N_R + N_S}{N_R} \qquad \text{Equation (1)}$$

In one embodiment of epicyclic gear system **32**, the ring gear has **117** teeth, the planet gears have 37 teeth, and the sun gear has 43 teeth such that a gear reduction ratio of about 1.37:1 is achieved. Thus, the rotational speed of first-stage fan shaft **28** is reduced to about seventy-three percent of that of second-stage fan shaft **30**, as is illustrated by equation (2), where $\omega_{Second\text{-}Stage}$ is the rotational speed of second-stage shaft **30** and $\omega_{First\text{-}stage}$ is the rotational speed of first-stage shaft **28**.

$$\omega_{Second\text{-}Stage} = \omega_{First\text{-}Stage}\left(\frac{N_R + N_S}{N_R}\right) \qquad \text{Equation (2)}$$

In another embodiment of the invention, the rotational speed of first-stage fan shaft **28** is reduced to about eighty-three percent of that of second-stage fan shaft **30**.

Additionally, epicyclic gear system **32** achieves more efficient torque transfer from compressor shaft **54** to first-stage shaft **28** and second-stage shaft **30**. Typical counter-rotating fan gas turbine propulsion systems utilize a differential gear system that transfers power from a single rotational input to two rotational outputs. Thus, both power outputs are derived from the gear system, which produces inefficiencies in the power transfer and requires more robust gear systems. Epicyclic gear system **32** of the present invention, however, permits power from compressor shaft **54** to be directly transferred to second-stage shaft **30**. Second-stage shaft **30** is directly coupled to compressor shaft **54** through fan shaft **26**. Thus, gear reduction inefficiencies only result in transferring power to first-stage shaft **28** from epicyclic gear system **32**. Also, since only first-stage shaft **28** receives power from gear system **32**, gear system **32** need only be sufficiently robust to transfer a portion of the power of compressor shaft **54**, rather than all of the power of compressor shaft **54**. This also permits epicyclic gear system **32** to achieve smaller diameters and more compact designs.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.

The invention claimed is:

1. A two-stage turbofan system for use in a gas turbine engine through which inlet air travels from an upstream direction to a downstream direction, the two-stage turbofan system comprising:
- a second-stage fan shaft for connection with a drive shaft in the gas turbine engine such that the second-stage fan shaft is driven at a speed of the drive shaft;
- a stationary torque tube having a fixed upstream portion for connection with a fan case in the gas turbine engine;
- a gear system comprising:
  - a ring gear connected to the second-stage fan shaft;
  - a stationary sun gear connected to a downstream portion of the torque tube concentric with the ring gear; and
  - a gear carrier positioned concentrically between the ring gear and the sun gear, the gear carrier having a plurality of planet gears positioned in the gear carrier to interface with the sun gear and the ring gear; and
- a first-stage fan shaft having a downstream portion extending from the gear carrier such that the first-stage fan shaft is driven at a speed reduced from that of the drive shaft.

2. The two-stage turbofan system of claim **1** wherein the gear system comprises an epicylic gear train.

3. The two-stage turbofan system of claim **1** and further comprising a plurality of journal pins positioned within the plurality of planet gears and connected to the carrier.

4. The two-stage turbofan system of claim **3** and further comprising:
- an oil manifold connected to the plurality of journal pins; and
- an oil feed extending through the stationary torque tube and connecting with the oil manifold.

5. The two-stage turbofan system of claim **4** wherein the plurality of journal pins include radially extending lubrication bores such that oil from the oil manifold can be centrifically driven from the oil manifold to the interface of the ring gear and the plurality of planet gears.

6. The two-stage turbofan system of claim **5** and further comprising an oil collection system for gathering oil centrifically passed through the gear system.